The utility of the temporalis muscle flap for oropharyngeal, base of tongue, and nasopharyngeal reconstruction

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OBJECTIVE: **To determine the efficacy of temporalis muscle flap reconstruction of various defects of the oropharynx, nasopharynx, and base of tongue.**

STUDY DESIGN: **Retrospective chart review of a consecutive series of 24 patients who underwent a total of 26 temporalis flaps (2 bilateral) by the senior author (Y.D.) from September 1997 to August 2003 for reconstruction of defects of the oropharynx, nasopharynx, and base of tongue.**

METHODS: **Variables and outcomes that were examined included defect location, size, adjunctive therapy, complications, and ability to tolerate oral intake at follow-up.**

RESULTS: **There was no evidence of flap failure in our series of patients. There were 2 cases of minor flap loss related to early prosthetic rehabilitation. Two cases of transient frontal nerve paralysis were noted. A 30.8% rate of complication (all minor) was noted in this study. At a mean follow-up of 12 months, 54.2% of patients were tolerating a full diet, 37.5% were tolerating most of their nutrition by mouth, and 8.3% were g-tube dependent.**

CONCLUSION: **The temporalis muscle flap represents an excellent alternative in reconstruction of otherwise difficult-to-reconstruct defects of the nasopharynx, oropharynx, and base of tongue. Donor site aesthetics are well accepted by patients with primary hydroxyapatite cement cranioplasty with or without secondary lipotransfer.** (Otolaryngol Head Neck Surg 2005;132:373-80.)

The temporalis muscle flap (TMF) is a reliable, nonbulky, myofascial flap which has been utilized for closure of a variety of defects within the head and neck region. Although Golovine (1898) was often thought to have originated the TMF, recent evidence has demonstrated that his method of reconstructing orbital exenteration defects was a forehead skin flap, and not a myofascial flap.[1-3] The first definitive use of the TMF was in the surgical treatment of temporomandibular joint ankylosis by Lentz (1895) and by Verneuil (1872) where it served as an interposition graft following resection of the conydylar neck.[3,4] Subsequently, Gillies (1917) utilized the TMF in rehabilitating cheek deformities resulting from traumatic loss of the zygomatic arch.[1,5] Stepwise modifications of his original surgical technique have extended the reach of the TMF for use in a multitude of locations within the head and neck. The limitation on the flap's use inferior to the zygomatic arch due to flap length was overcome by Sheehan (1935) through his description of zygomatic arch osteotomy.[3] Rambo (1958) obliterated the middle ear and mastoid cavities with the TMF in cases of chronic ear disease.[3,6] Bakamjian (1963) demonstrated its utility in reconstructing defects of the palate following tumor resection.[3]

A wide variety of local flaps, pedicled flaps, and free-tissue transfers have been employed for reconstruction of combined defects of the oral cavity and pharynx following extirpation of retromolar trigone, tonsil, nasopharyngeal, and base of tongue cancers. Many of these flaps have met with mixed success functionally.

In this article, we review our favorable experience utilizing the temporalis muscle flap for reconstruction of oral cavity, oropharyngeal, and nasopharyngeal defects.

ANATOMY

The temporalis muscle is a fan-shaped muscle that originates from the temporalis fascia and from the temporal fossa.[7,8] The muscle emanates anteriorly to the lateral orbital rim and anterior temporal crest, posteriorly towards the occiput, and superiorly to the infratemporal crest.[4,6,7] It passes deep to the central part of the zygomatic arch, inserting onto the coronoid process and the anterior border of the ascending ramus of the mandible. As such, the temporalis muscle functions as both an elevator and a retractor of the mandible.[4,7,8]

The soft tissue of the scalp in the region of the temporalis muscle can be divided into distinct layers, knowledge of which is critical in order to avoid inadvertent injury to the frontal branch of cranial nerve

seven. There have been several names applied to the same structures, resulting in occasional confusion by the novice surgeon.

The most superficial soft tissue layer in the temporal region is the skin and subcutaneous tissue, which contain pilosebaceous units, hair follicles, and capillaries. Deep to this layer lies the temporoparietal fascia (also known as the superficial temporal fascia), which is an extension of the galea aponeurotica (also called the epicranium). Along the lateral border, the galea aponeurotica is contiguous with the temporoparietal fascia (superficial temporal fascia) at the superior temporal line.[9] The temporoparietal fascia continues inferiorly where it becomes contiguous with the superficial musculoaponeurotic system (SMAS).[10,11] The galea aponeurotica is composed of dense fibrous tissue that fuses with the frontalis muscle anteriorly and the occipitalis muscle posteriorly. The temporal branch of the facial nerve lies just deep to the temporoparietal fascia after it passes cephalad to the zygomatic arch. At the level of the zygomatic arch this nerve typically has 2 to 5 branches. Deep to the temporoparietal fascia, there is a layer of subaponeurotic connective tissue referred to as the subgaleal fascia which is composed of a central dense, collagenous material surrounded by vascularized loose areolar tissue.[10] This layer provides the scalp with mobility, allowing for movement of the galea over the underlying, fixed periosteum.[11] The subgaleal fascia is continuous with the loose areolar layer that lies deep to the orbicularis oculi muscle. The branches of the facial nerve that supply the orbicularis oculi lie just superficial to this layer. In the temporoparietal region this layer is indistinguishable from the superficial temporal fascia.

The superficial layer of the deep temporalis fascia lies beneath the subaponeurotic connective tissue. The "pericranium" is usually defined as the combination of the subgaleal fascia and the adherent periosteum overlying the skull.[9,12-15] The deep temporal fascia overlies the temporalis muscle and is continuous with the pericranium cephalad to the superior temporal line.[11,13,14] Inferior to the level of the superior orbital rim, the deep layer of the temporal fascia divides into the so-called superficial and deep layers of the deep temporal fascia. The superficial layer of the deep temporal fascia attaches to the lateral border of the zygomatic arch while the deep layer of the deep temporal fascia attaches to the medial border of the zygomatic arch. The superficial temporal fat pad lies between the superficial and deep layers of the deep temporal fascia.

The main vascular supply to the TMF is derived from the anterior and posterior deep temporal arteries, which originate from the second (pterygoid) portion of the internal maxillary artery and enter the deep surface of the muscle, most commonly in the inferior third of the muscle within its posterior one-half.[5,7] The deep temporal artery courses between the skull and temporalis muscle, joining the middle temporal artery within the temporalis muscle. The middle temporal artery is a branch of the superficial temporal artery, which usually originates 0 to 2 cm below the zygomatic arch and courses just posterior to the superficial temporal artery (STA). The middle temporal artery then enters the deep temporal fascia immediately superior to the zygomatic arch.[11] It continues its course superiorly and sends some perforators deep, into the temporalis muscle.

The anterior and posterior deep temporal nerves arise from the mandibular division of the trigeminal nerve to supply the temporalis muscle.[7] The temporal branches of the facial nerve emanate from the superior aspect of the parotid gland just inferior to the zygomatic arch. These nerve branches are protected by fibrous bands, which pass from the zygomatic arch to the superficial temporal fat pad.

Once harvested, the TMF typically spans a length of 12 to 16 cm, with a thickness of 0.5 to 1.0 cm, and tolerates an arc of rotation up to 135 degrees.[7,16] The TMF is a flexible, well-vascularized, innervated, myofascial, pedicled flap which may be tunneled through the infratemporal fossa for use in intraoral reconstruction.

MATERIAL AND METHODS

A retrospective chart review was conducted at a tertiary referral medical system on a consecutive set of patients who underwent reconstruction with a pedicled temporalis muscle flap by the senior author (Y.D.). Patients were located by search for CPT codes and flap reconstructions. Patient demographics, outcomes, follow-up, and complications were recorded. From September 1997 to August 2003, a total of 26 patients received 28 temporalis flaps for reconstructing defects located in the retromolar trigone, base of tongue, nasopharynx, and oropharynx. Unfortunately, two charts were unavailable for review, and the data for only 24 patients receiving 26 flaps was analyzed. Data were obtained on age of patient, size of defect, area of defect, type of pathology causing the defect, follow-up, ability to tolerate a postoperative diet, and complications.

Technique

The temporalis muscle flap is accessed through a pretragal incision, which extends superiorly into the hairline. Initially, early in our series, the incision was extended into a "Y" shape at the vertex of the incision. More recently, we have simply curved the vertical limb anteriorly for a short distance. We feel this has refined the aesthetic outcome. We recommend that the incision

Fig 1. Right-sided temporalis muscle flap has been raised and zygoma has been preplated.

Fig 2. Left-sided temporalis muscle flap has been transferred intraorally following coronoidectomy to fill a large base of tongue defect left following tumor extirpation. *F*, temporalis flap; *t*, base of tongue defect.

continue in a vertical fashion in the preauricular area as it makes dissection and plating along the zygomatic arch much more facile. The deep temporal fascia is exposed by elevating anterior and posterior skin flaps to the margins of the temporal fossa. Inferiorly, the dissection continues to the level of the superficial temporal fat pad. Once this fat pad is identified, the superficial layer of the deep temporal fascia is incised and further dissection anteriorly and inferiorly is carried out deep to this layer. This protects the temporal branch of the facial nerve and leads the dissection directly to the zygomatic arch. The periosteum is elevated from the malar eminence, exposing the zygomatic arch in its entirety. In certain patients with little skin laxity, retraction of the soft tissue overlying the arch may lead to frontal branch neuropraxia, which is generally temporary. A 1.3- or 1.5-mm miniplate is then predrilled from the malar eminence to the root of the zygomatic arch (Fig 1). A side-cutting bur is used to complete osteotomies in the arch; the arch is then removed and soaked in normal saline until it is replaced at the completion of the procedure. The deep muscular fascia is elevated from the superior temporal line with an elevator. The temporalis and its fascia are freed from the skull to the
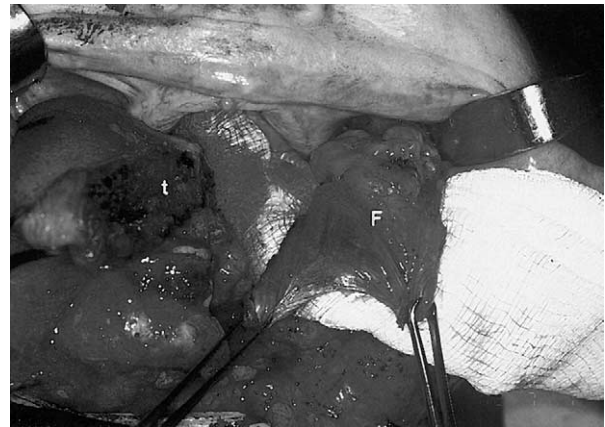
level of the coronoid process. Blunt dissection should always be used in this area to protect the deep temporal vascular system. If further length is required for reconstructing contralateral or anterior defects, the coronoid process may be osteotomized transorally, gaining a further 1.5 cm of pedicle length. The flap is then gently transferred intraorally through a transbuccal tunnel. This tunnel allows for transfer of the flap through the infratemporal fossa and the cheek and should allow a minimum of two fingerbreadths to pass easily and prevent flap pedicle compression. The flap is secured into place with vicryl sutures in a two-layer fashion (Figs 2-6). A skin graft can be applied, but is generally not necessary as this flap will mucosalize nicely over time.

The temporal incision and temporalis fossa are then irrigated. The zygomatic arch is secured with the predrilled 1.5- or 1.3-mm miniplate and 4-mm screws. A cranioplasty is performed with hydroxyapatite bone cement to fill the defect that is left in the absence of the muscle (Fig 7). Various forms of hydoxyapatite cement (Norion from Synthes, Paoli, PA; Mimix from Lorenz, Jacksonville, FL; Bonesource from Stryker-Leibinger, Kalamazoo, MI) were utilized in approximately equal numbers in this study. The bone cement is placed until the contour deficit of the temporal fossa has been filled utilizing the contralateral normal side as a visual control. We place the bone cement to within 1 cm of the zygomatic arch to avoid hydroxyapatite placement in contact with the harvested muscle flap. In all but 6 patients (who did not desire further surgery), the margins of the temporal fossa were softened with standard lipotransfer technique. The resulting contour of the temporal fossa was judged to be excellent by all surveyed patients, including the subset of patients not

Fig 3. Six-month postoperative result of patient in Figure 2 showing well-mucosalized flap in left base of tongue.

Fig 4. Temporalis flap transferred into position to rehabilitate a large nasopharyngeal and oropharyngeal defect following excision of skull base neoplasm (palate was also removed and subsequently rehabilitated with a planned obturator). Forceps are drawing the temporalis muscle flap medially.

Fig 5. Well-healed and mucosalized flap from patient pictured in Figure 4 at 6 months (obturator has been removed to allow for visualization of the nasopharyngeal aspect of the flap).

Fig 6. One-year postoperative result of another patient who had undergone reconstruction of the right palate, retromolar trigone, and lateral aspect of base of tongue with a temporalis flap.

desiring further intervention. We generally perform lipotransfer secondarily to soften the contour and fine-tune any residual deformities long-term utilizing an intra-umbilical access site. Fat is harvested with 2- to 3-mm cannulas with tumescent technique and after removal of the free fatty acid and serous layers, it is injected into the recipient site (Figs 8-11). All but 2 patients required only a single lipotransfer to achieve their final aesthetic outcome.

RESULTS

Twenty-four patients had completed data that was retrospectively analyzed. Major complications were considered flap loss or permanent injury to the temporal branch of the facial nerve. Minor complications in-

clude: infection, seroma, hematoma, temporary nerve palsy, hair loss, trismus, and aesthetic donor site complications. Each of these patients had one of the following indications for reconstruction with a pedicled temporalis muscle flap: an extensive deficit created by the removal of a lesion in the retromolar trigone, base of tongue, oropharynx, or nasopharynx. Most of the patients had lesions in more than 2 of the areas noted above. Two of the patients received bilateral temporalis flaps, one patient concurrently and one patient during 2 separate operations. Twenty of the lesions were malignant, and 4 were extensive benign processes. Of the 20 malignant processes, 15 lesions were classified as T4, and 5 were classified as T3. The most common pathologic diagnosis was squamous cell carcinoma (n = 15), followed by adenoid cystic carcinoma (n = 3). The

Fig 7. Zygomatic arch has been plated and hydroxyapatite cement cranioplasty has been performed at the conclusion of flap harvest and inset.

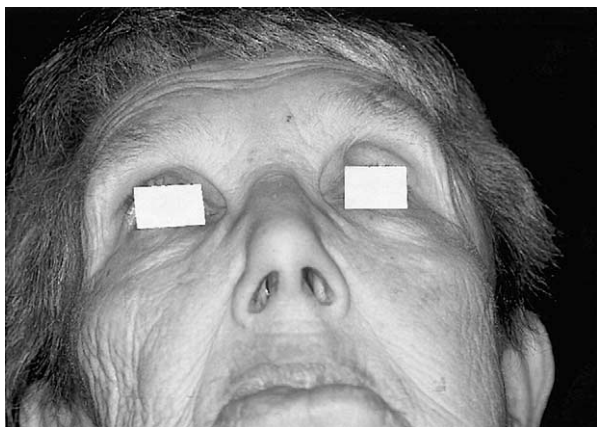**Fig 9.** Postoperative frontal view of patient shown in Figure 8.

Fig 8. Nine months postoperative basal view of patient who had undergone left temporalis muscle flap reconstruction of the oropharynx and base of tongue. Reasonable symmetry is present.

Fig 10. One year postoperative basal view of patient who had undergone right temporalis muscle reconstruction of a base of tongue and nasopharynx carcinoma. She has a history of having had a remote laryngectomy for a separate carcinoma.

average patient age was 59.1 years (range, 43.9-77.8). There were 13 males and 11 females. The mean follow-up period for this study was 12 months (range, 1.5-59.5 months).
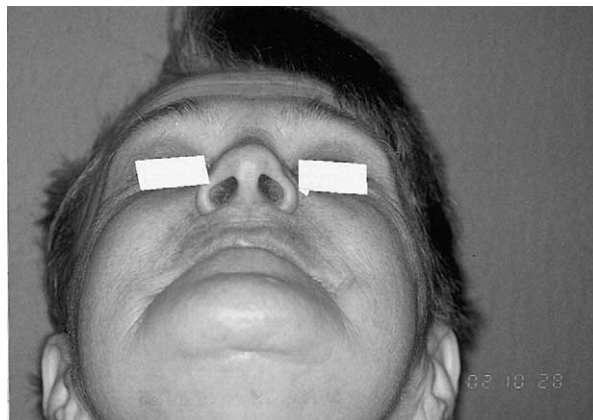
For the purposes of this study, width was measured in a medial to lateral dimension, and length was measured in an anterior to posterior dimension. The average defect width was 6.0 cm ± 2.0 cm, and the average defect length
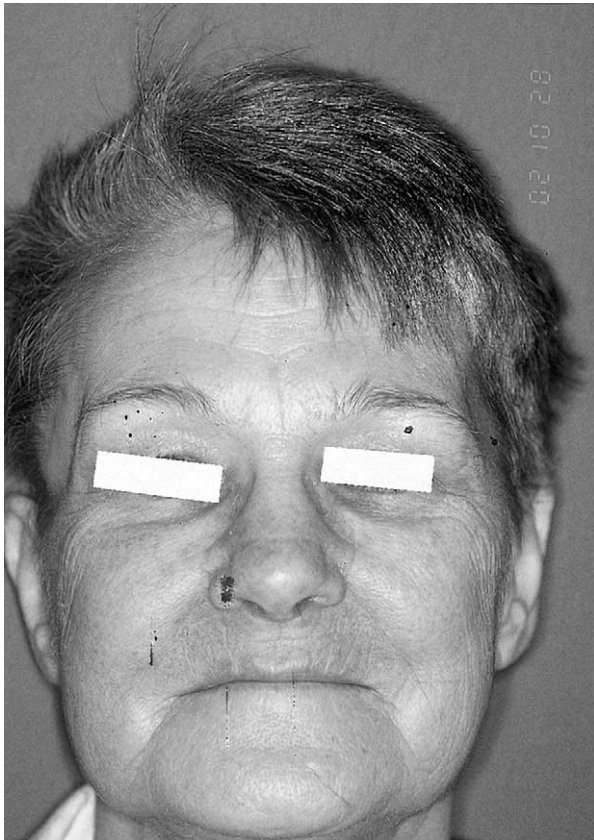
Fig 11. Postoperative frontal view of patient shown in Figure 10.

was 5.8 cm $\pm$ 1.2 cm. Of the 26 pedicled temporalis flaps, 14 were left-sided, and 12 were pedicled from the right. Seven patients received preoperative radiation therapy, and 13 patients received postoperative radiation therapy. Four patients had received preoperative chemotherapy, and 3 patients received postoperative chemotherapy. All 24 patients received an average of 30 grams (range, 10-100 g) of hydroxyapatite cement for the temporal fossa cranioplasty as part of their primary reconstructive procedure. We employed a split-thickness skin graft in only 2 patients, but did not find it necessary in others. In these patients, the skin graft was used for defects adjacent to the temporalis and not just on the temporalis muscle flap itself. All of the flaps were well mucosalized within 14 to 21 days.

Thirteen of the 24 patients were tolerating a full diet by mouth at follow-up (54.2%). Nine patients of 24 were tolerating most of their intake by mouth (37.5%), and 2 patients were unable to tolerate any nutrition by mouth at the end of the follow-up period but were able to handle secretions safely (8.3%).

Throughout the follow-up period only minor complications were noted, and all but 3 were temporary in nature. Two patients experienced minor partial flap loss requiring debridement. One was related to an ill-fitting prosthesis and the other to dehiscence due to early (1 week) prosthetic rehabilitation with a bulb prosthesis. Two other patients experienced a temporary frontal nerve neuropraxia as a result of traction. One patient needed a local flap for closure of a small temporal incision site dehiscence. One patient receiving postoperative chemotherapy developed a seroma over the hydroxyapatite reconstruction; this area was treated conservatively with needle drainage and ultimately resolved with no further intervention.

None of the patients was found to have zygomatic hardware exposure during the follow-up period. Only one patient was found to have an infection of the hydroxyapatite material, and this was subsequently removed with resolution of the infection. This patient underwent subsequent lipotransfer alone with excellent outcome following a single injection and no need for further surgery. Overall, 8 of 26 TMF flaps had minor complications (30.8%). All of these 8 patients had radiation therapy in combination with surgery as treatment for their disease. Four of the 8 also had either preoperative or postoperative chemotherapy as part of their treatment. There were no major complications or mortality as a result of the procedures performed.

DISCUSSION

The temporalis muscle flap provides a large bulk of tissue to aid in the restoration of large and complex oral cavity, oropharyngeal, and nasopharyngeal defects. Its versatility and extended range make it appropriate for defects extending as far as the anterior floor of the mouth, the ipsilateral cheek, the anterior tongue, or the tongue base. When we utilize this flap for anterior floor of mouth or anterior tongue defects, we routinely divide and inset the transbuccal portion at approximately 3 weeks to prevent tethering. The flap can easily reach across the contralateral palate as well, to cover total palatal defects. The TMF has a reliable blood supply while maintaining an effective arc of rotation of 120 to 130 degrees.[7,17] Aesthetically, the TMF is accessible through a scalp incision, leaving a scar that is camouflaged in the hair-bearing skin and the preauricular crease.

In our experience we have not found the need for split-thickness skin grafts to cover the intraoral surface. All flaps were mucosalized within 14 to 21 days, and similar findings have been reported by several authors in the past.[2,4,7,8,16,18]

The overall minor complication rate of 30.8% is in keeping with other similar studies, once our minor

complications are grouped into the categories noted above.[2-4,6,19] Two of our patients experienced frontal branch palsies after flap elevation. These were thought to be traction injuries because of their transient nature. Clauser et al reported a 19.2% temporal branch paresis and a 2.7% incidence of paralysis.[3] Injury to the temporal branch of the facial nerve can be avoided by reducing traction of the anterior scalp flap as one elevates the superficial and deep temporal fascia from the zygomatic arch to which they are quite adherent.

Clauser et al described partial flap loss in his series as 13.4%.[3] We experienced 2 small partial flap losses with associated dehiscence (7.7%). There were no cases of complete flap loss in our series. Limited mouth opening was also reported by Clauser as 9.3%; we had one patient (3.8%) with trismus, which was exacerbated by postoperative radiation therapy. The patient is currently undergoing rehabilitation for her trismus, and is able to tolerate a liquid diet.

Rehabilitation of the donor site defect remains one of the long-standing controversies surrounding the use of the TMF. Multiple methods have been employed to fill the temporalis muscle defect, including lyophilized bovine cartilage, silastic, polyethylene, dermal fat grafts, and hydroxyapatite.[3] Alonso del Hoyo et al used silicone implants and methylmethacrylate.[2] Others have reported favorable results with utilization of the entire TMF flap for reconstruction, replacing the zygomatic arch, and leaving the fat pad in place.[4] Still others have advocated not reconstructing the hollowed temporal fossa.[19] Some authors have chosen the more radical approach of removing the masseter muscle, in cases of hemimandibulectomy patients, to decrease contour irregularities.[16] Recently, hydroxyapatite cements have become readily available. We used hydroxyapatite to initially reconstruct the temporal defects. The hydroxyapatite bone cement allows the surgeon to fill the defect without contour irregularity and without the potential donor site morbidity that other autologous reconstruction materials carry. Only one (4%) of the cemented areas became infected; this was subsequently removed and the patient reconstructed with only lipotransfer, resulting in an excellent outcome aesthetically. As the hydroxyapatite cement is not within the standard radiation field for nasopharyngeal, oropharyngeal, or base of tongue carcinomas, this seems to be a reasonable reconstructive modality. When placing large amounts of hydroxyapatite cement in the temporal fossa, one would expect a fibrous capsule around the implant to develop with ingrowth of bone into the periphery of the construct.

We do not believe that the entire construct is replaced by bone but instead feel that the peripheral ingrowth into the implant will result in long-term stability, which we have seen not only at this but at other sites within the craniomaxillofacial skeleton. We do offer some of our patients secondary lipotransfer to the temporal fossa to soften the ultimate appearance of this area and to alleviate any residual minor soft tissue asymmetries.[20] We have found this to be a useful technique associated with favorable aesthetic outcomes in our patient population.

CONCLUSION

The TMF flap is a thin, pliable, well-vascularized flap that is locally available and well suited to reconstruct a variety of defects in the oral cavity, oropharynx, and nasopharynx. Major complications rarely occur and the incidence of minor complications is consistent with other pedicled flaps used for reconstruction of oral cavity and oropharyngeal defects. The temporal fossa defects can be corrected with a variety of techniques, although we have found primary hydroxyapatite cement with occasional secondary lipotransfer to be reliable and aesthetically pleasing.

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